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AUTHOR Loyd, Brenda H.
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ABSTRACT

This study determined if overall mathematics performance of male and female students was: (1) different within each of six content areas; (2) differentially affected by ability grouping within each of the six content areas; and (3) differentially affected by the combination of ability grouping and grade level within each of the six content areas. Subjects were 963 students from grade 3 (N=241), grade 4 (N=245), grade 5 (N=260), and grade 6 (N=217). All subjects took a 45-item, multiple-choice test measuring concepts in six categories: numeration and number systems; equations and inequalities; whole numbers; fractions; decimals, currency, and percent; and geometry and measurement. Results indicate significant differences (favoring males) in three of the content areas: numeration and number systems; decimals, currency and percent; and geometry and measurement. A significant sex by ability effect was found only for geometry and measurement. Females performed better than males for low ability students; males performed better than females for high ability students. Sex by grade effect was not demonstrated to be significant for any of the six areas. These results are consistent with research findings indicating that when sex differences are found they favor males. (JN)

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THE IMPACT OF SEX, ABILITY, AND ITEM TYPE ON MATHEMATICS PERFORMANCE

Brenda H. Loyd

University of Virginia

Presented at the
Annual Meeting of the
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THE IMPACT OF SEX, ABILITY, AND ITEM TYPE ON MATHEMATICS PERFORMANCE

Brenda H. Loyd

University of Virginia

Sex differences in mathematics achievement have recieved much attention in current research literature and periodicals. Reviews of such research (Fennema, 1974; Badger, 1981) have attempted to reach some consensus on the relationship between the sexes and mathematics, but the results have not been consistent. Research seems to indicate a clear change in mathematics performance with age, but the ability level and range have varied from study to study, leaving open the possibiltiy that the relationship may vary with abiltiy. Even when efforts may have been reasonably successful in describing the relationship, they have not been particularly useful in determining the reasons why differences occur when they do, or suggesting in what areas educators can modify their instruction to promote maximum math achievement for both sexes.

In an effort to add information to this body of research, two potential sources of variation between the sex groups were selected for study. The first was the ability level of pupils; the second was the area of mathematics measured. To study the latter 6 item types were developed, with each type presenting an area of general mathematics curriculum that is present in the elementary grades.

The six types of items or areas of elementary mathematics were specified by the following six categories. The first category was Numeration and Number Systems. Included in this category were concepts

of counting, number series, place values, sets, and properties of number systems. The second category was Equations and Inequalities. Included in this category were the use of operational and relational symbols and the solution of number sentences. The third category was Whole Numbers and included reading whole numbers, number facts, and ways to perform fundamental operations with whole numbers. The fourth category was Fractions and included concepts of partitioning sets, ways to perform fundamental operations with fractions, ratios, and proportions. The fifth category was Decimals, Currency, and Percent. This category included concepts of reading decimals, relative values, ways to perform fundamental operations with decimals, ways of estimating results and rounding with decimals, and equivalence of decimals, fractions, and percents. The sixth category was Geometry and Measurement. This category included the concepts of measuring quantity, temperature, time, length, and weight, recognizing types and parts of geometric figures, and figuring the area and perimeter of figures.

The study attempted to answer the following specific questions as they pertain to fifth grade and eighth grade pupils:

1. Is the overall performance of male and female pupils different within each of the six content areas?
2. Is the performance of male and female pupils differentially affected by ability grouping within each of the six content areas?
3. Is the performance of male and female pupils differentially affected by the combination of ability grouping and grade level with each of the six content areas?

METHOD

Test Materials.

One test containing 45 items was constructed to measure the set of concepts. Of the 45 items 7 measured Numeration and Number Systems, 6 measured Equations and Inequalities, 7 measured Whole Numbers, 9 measured Fractions, 7 measured Decimals, Currency and Percent, and 9 items measured Geometry and Measurement. The items of the test progressed in difficulty from those which would be appropriate to the typical third grade pupil through those which would be appropriate to the typical eighth grade pupil. The items were all constructed in a multiple choice format. Examples of each of the six content areas are presented in Figure 1.

Procedure.

The test was administered to a total of 963 pupils selected from grades 3 through 6 in 12 school districts in the state of Iowa. Of the entire sample, 241 were third grade pupils, 245 were fourth grade pupils, 260 were fifth grade pupils, and 217 were sixth grade pupils.

Analysis.

The item data from the 45 items were collected and six scores were obtained for each pupil, one for each of the six content areas.

The data were analyzed by a three factor analysis of variance procedure. The first factor was Sex, the second factor was Grade (Grade 3-6), and the third factor was Ability. Ability level was determined for each grade level by performance on a second mathematical concepts test which was developed to measure typical performance within that grade. Three ability levels were specified according to scores on the in-grade mathematics tests. The low ability group corresponded approximately to the lowest 20% in the grade group. The high ability group represented approximately the upper 20% of

the grade group. The middle ability level represented the middle 60% of the grade group.

The hypotheses of interest were:

1) H_o There is no sex difference in mathematics performance.

2) H_o There is no sex by ability difference in mathematics performance.

3) H_o There is no sex by grade difference in mathematics performance.

There were six analyses of variance procedures run, one for each of the six mathematics concepts areas.

Results and Discussion.

The results of the six analyses of variance procedures are presented in Tables 1 through 6. For three of the six content areas, there was a significant sex effect. These were Numeration and Number Systems; Decimals, Currency and Percent; and Geometry and Measurement. For the other three (Equations and Inequalities; Whole Numbers; and Fractions) the sex effect was not shown to be statistically significant. For each area where statistically significant differences were demonstrated, males performed better than females. The mean performances for each math area presented by grade, sex and ability are also presented in Tables 1 through 6.

For only one mathematics area was there a significant sex by ability effect--Geometry and Measurement. For low ability pupils, females performed significantly better than males. For high ability students males performed significantly better than females. For middle ability students the difference by sex was not statistically significant.

The sex by grade effect was not shown to be statistically significant for any of the six areas.

The findings of this study are consistent with the review of research on sex differences in math reported by Badger, 1981: when sex differences are found they favor males. Although these pupils were in elementary school, the differences in performance on geometry and measurement items is consistent with that reported for older students in grades 7 through 12.

REFERENCES

Badger, M.E. Why aren't girls better at Maths? A review of research. Educational Research, 1981, 24(1), 11-23.

Fennema, E. Sex differences in mathematics achievement: A review. Journal for Research in Mathematics Education, 1974, 5, 126-139.

Figure 1

NUMERATION AND NUMBER SYSTEMS Examples of Item Types

How would you read 1025?

1) One thousand twenty-five
2) Ten thousand twenty-five
3) One thousand two hundred fifty
4) One hundred twenty-five

Which of the following represents a prime number?

1) 6 2) 7 3) 8 4) 9

EQUATIONS AND INEQUALITIES

What should replace the $\square$ in the number sentence $(4 - 3) + 6 = 6 + (\square - 3)$?

1) 9 3) 3
2) 4 4) 1

What should replace n in the equation $4n + 8 = 24$?

1) 2 2) 4 3) 6 4) 8

WHOLE NUMBERS

How many sixes must be subtracted from 24 to get 0?

1) 3 3) 5
2) 4 4) 6

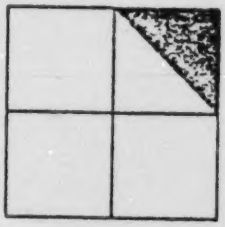
If 313 is rounded to the nearest ten, what is the resulting number?

1) 300 3) 320
2) 310 4) 400

FRACTIONS

What part of the picture below is shaded?

1) $\frac{1}{2}$
2) $\frac{1}{4}$
3) $\frac{1}{8}$
4) $\frac{1}{16}$



Which expression below is *not* equivalent to $\frac{6}{8}$?

1) $\frac{6 \div 2}{8 \div 2}$ 3) $\frac{6}{8} \times \frac{3}{3}$
2) $\frac{6 \times 2}{8 \times 2}$ 4) $\frac{6 + 2}{8 + 2}$

DECIMALS, CURRENCY, PER CENT

How would you read 7.02?

1) 7 point 2
2) 7 and 2 tenths
3) 7 and 2 hundredths
4) 7 and 2 thousandths

Which of these numerals represents the greatest number?

1) .307 3) 3.07
2) .730 4) 3.7

GEOMETRY AND MEASUREMENT

Bob's room is 12 feet long and 8 feet wide. How many square feet of floor space does he have in his room?

1) 20 3) 48
2) 40 4) 96

What is the perimeter of the figure below?

1) 17'
2) 18'
3) 24'
4) 26'

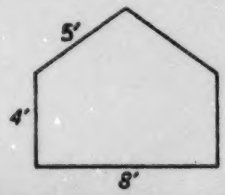


Table 1
Numeration and Number Systems
(7 items)
Means (N)

		Ability Low	Middle	High	Total
Grade 3	M	1.15	2.15	3.19	2.21 (112)
	F	1.32	1.59	2.86	1.77 (129)
Grade 4	M	2.25	3.26	4.57	3.24 (135)
	F	2.14	2.99	4.44	3.05 (110)
Grade 5	M	2.60	4.09	4.72	3.92 (128)
	F	2.36	3.93	4.65	3.73 (132)
Grade 6	M	3.12	4.72	5.68	4.54 (95)
	F	3.39	4.65	6.00	4.48 (95)

Summary of Analysis of Variance

Source	df	MS	F
Sex (S)	1	11.4	7.8 150.4*
Grade (G)	3	297.5	8.0*
Ability (A)	2	230.1	208.1*
S x G	3	1.8	1.3
S x A	2	1.2	.9
G x A	6	3.5	2.4*
S x G x A	6	1.1	.8
Residual	939	1.4	

*p < .05

Table 2
Equations and Inequalities
(6 items)

Means (N)

		Ability Low	Middle	High	Total
Grade 3	M	.90	.82	1.23	.93 (112)
	F	.89	.89	1.86	1.05 (129)
Grade 4	M	1.16	1.74	2.75	1.74 (135)
	F	1.18	1.87	2.67	1.86 (110)
Grade 5	M	1.20	2.20	3.53	2.16 (128)
	F	1.52	2.23	2.80	2.18 (132)
Grade 6	M	1.84	2.91	3.79	2.83 (122)
	F	1.74	3.32	3.90	3.00 (95)

Summary of Analysis of Variance

Source	df	MS	F
Sex (S)	1	3.0	2.2
Grade (G)	3	159.7	116.9*
Ability (A)	2	97.2	71.1*
S x G	3	0.8	0.6
S x A	2	0.2	.1
G x A	6	6.1	4.5*
S x G x A	6	2.0	1.5
Residual	939	1.4	1.5

*$p < .05$

Table 3
Whole Numbers
(7 items)

Mean (N)

		Ability Low	Middle	High	Total
Grade 3	M	2.50	2.59	4.38	2.99 (112)
	F	2.00	2.61	4.05	2.77 (129)
Grade 4	M	2.78	4.45	6.04	4.33 (135)
	F	3.00	4.37	5.50	4.28 (110)
Grade 5	M	3.43	5.08	6.00	4.83 (128)
	F	3.60	5.18	5.70	4.96 (132)
Grade 6	M	3.76	5.38	6.11	5.16 (122)
	F	3.96	5.63	6.60	5.33 (95)

Summary of Analysis of Variance

Source	df	MS	F
Sex (S)	1	0.0	.0
Grade (G)	3	289.4	163.8*
Ability (A)	2	275.4	155.9*
S x G	3	1.7	.9
S x A	2	1.3	.7
G x A	6	8.3	4.7*
S x G x A	6	0.9	.5
Residual	939	1.7	

*$p < .05$

Table 4
Fractions
(9 items)

Mean (N)

		Ability Low	Middle	High	Total
Grade 3	M	1.55	1.47	2.15	1.64 (112)
	F	1.42	1.39	1.82	1.47 (129)
Grade 4	M	1.84	2.42	3.96	2.55 (135)
	F	1.82	2.43	3.22	2.44 (110)
Grade 5	M	2.00	3.38	5.26	3.34 (128)
	F	2.00	3.20	4.55	3.21 (132)
Grade 6	M	2.36	4.18	6.42	4.16 (122)
	F	2.26	4.05	6.40	3.86 (95)

Summary of Analysis of Variance

Source	df	MS	F
Sex (S)	1	5.8	2.5
Grade (G)	3	286.4	122.9*
Ability (A)	2	217.2	93.2*
S x G	3	.1	.0
S x A	2	2.8	1.2
G x A	6	23.1	9.9*
S x G x A	6	.7	.3
Residual	939	2.3	

*$p < .05$

Table 5
Decimals, Currency, Percent
(7 items)

Mean (N)

		Ability Low	Middle	High	Total
Grade 3	M	.95	1.41	1.31	1.30 (112)
	F	1.11	1.11	1.45	1.17 (129)
Grade 4	M	1.28	1.72	2.39	1.73 (135)
	F	1.50	1.53	2.29	1.65 (110)
Grade 5	M	2.03	2.47	3.84	2.57 (128)
	F	1.68	2.06	3.35	2.18 (132)
Grade 6	M	2.12	3.40	4.89	3.37 (122)
	F	2.00	3.23	5.10	3.13 (95)

Summary of Analysis of Variance

Source	df	MS	F
Sex (S)	1	9.9	7.6*
Grade (G)	3	188.3	145.5*
Ability (A)	2	85.5	66.0*
S x G	3	1.4	1.1
S x A	2	1.3	1.0
G x A	6	13.5	10.5*
S x G x A	6	.4	.3
Residual	939	1.3	

*$p < .05$

Table 6
Geometry and Measurement
(9 items)

Mean (N)

		Ability Low	Middle	High	Total
Grade 3	M	1.35	2.27	3.08	2.29 (112)
	F	2.26	2.32	2.55	2.35 (129)
Grade 4	M	2.47	3.22	5.13	3.37 (135)
	F	2.50	3.01	4.28	3.12 (110)
Grade 5	M	2.73	4.37	6.53	4.30 (128)
	F	2.76	4.25	5.10	4.10 (132)
Grade 6	M	3.52	5.45	6.89	5.28 (122)
	F	3.74	5.03	6.70	4.89 (95)

Summary of Analysis of Variance

Source	df	MS	F
Sex (S)	1	7.9	4.2*
Grade (G)	3	361.7	189.7*
Ability (A)	2	242.6	127.3*
S x G	3	2.3	1.2
S x A	2	12.5	6.6*
G x A	6	12.5	6.6*
S x G x A	6	1.6	.9
Residual	939	1.9	

*$p < .05$